

In-Process Temperature Measurements for Feedback Control of Solid State Joining, Phase I

Completed Technology Project (2018 - 2019)



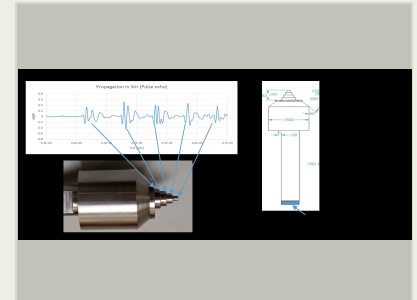
Project Introduction

This Phase I program addresses the NASA needs for Technical Area TA12 which provides technologies supporting advanced manufacturing, structures, and materials. In this program, ultrasonic thermometry methods will be adapted to enable real time, temperature measurements during a friction stir weld, FSW. While FSW it has been successfully used at NASA-MSFC in the robust joining of thinner panels of aluminum alloys, the production of high quality welded joints in thicker panels or higher melting temperature materials remains challenging. Knowing and controlling the temperature is essential to optimize the process to ensure the production of repeatable, robust components. Using sensors attached to the stir weld tool, precise time-of-flight (ToF) measurements of ultrasound propagating through the weld zone will be used to estimate temperature. This temperature measurement made in the weld zone is non-intrusive and does not influence the thermal transport. Temperature data can be obtained at data rates as high as 1 kHz with the precision of a few degrees Centigrade. Once this "smart" stir weld tool temperature sensor is demonstrated, this technique can be incorporated into a control strategy and readily migrated to any of the FSW variations under development at the NASA-MSFC.

Anticipated Benefits

The "smart" friction weld stir tool temperature concept demonstrated in this Phase I program addresses the needs of NASA's advanced manufacturing, structures, and materials road map. This temperature measurement technology is generally applicable to all solid state welding processes such as friction stir, thermal stir, and ultrasonic stir welding. Applications include a wide range of NASA programs that require high performance, low cost, innovative, propulsion systems and spacecraft components.

The "smart" stir weld tool with integrated temperature sensor is applicable to all solid state joining processing methods. Commercial companies pursuing FSW technologies include: Boeing, Airbus, Hayes wheels, Williams International, ULA, and Lockheed-Martin. This technology is also of interest to FSW equipment manufacturers/service providers e.g. General Tool Co., Concurrent Technologies Corporation, The Welding Institute, Manufacturing Technology, Inc., and Edison Welding Institute.



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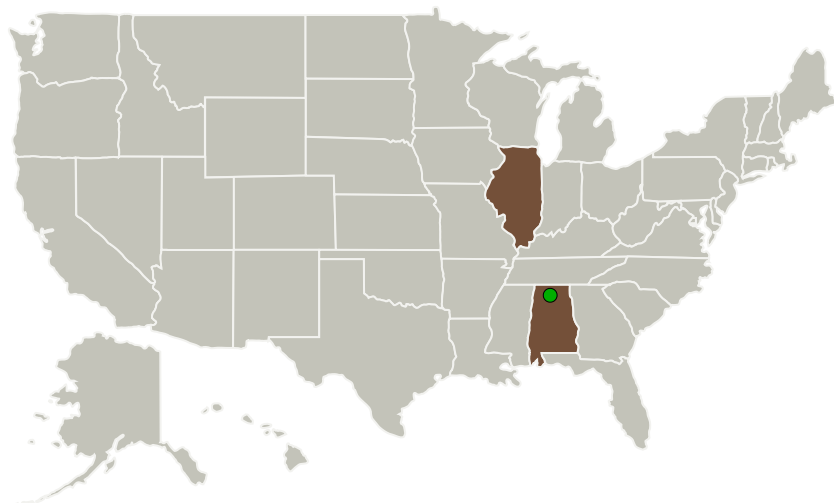
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Industrial Measurement Systems Inc.	Lead Organization	Industry	Aurora, Illinois
● Marshall Space Flight Center (MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Illinois

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/141827>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Industrial Measurement Systems Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

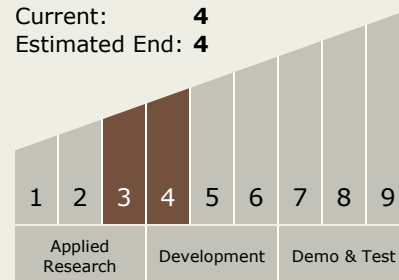
Carlos Torrez

Principal Investigator:

Donald E Yuhas

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**

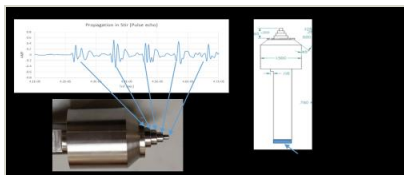


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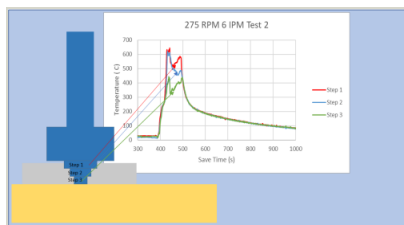


Images



Briefing Chart Image

In-Process Temperature Measurements for Feedback Control of Solid State Joining, Phase I
(<https://techport.nasa.gov/image/131800>)



Final Summary Chart Image

In-Process Temperature Measurements for Feedback Control of Solid State Joining, Phase I
(<https://techport.nasa.gov/image/127634>)



Final Summary Chart Image

In-Process Temperature Measurements for Feedback Control of Solid State Joining, Phase I
(<https://techport.nasa.gov/image/132493>)

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
 - └ TX12.1 Materials
 - └ TX12.1.2 Computational Materials

Target Destination

Others Inside the Solar System